

WHAT IS CLAIMED IS:

1. An apparatus for delivering a closure element into an opening through tissue, comprising:

an elongate member comprising proximal and distal ends;

5 a carrier assembly slidable on the elongate member, the carrier assembly comprising an inner carrier member, a middle pusher member, and an outer sleeve member, each member comprising an annular body including a connector on its proximal end, the pusher member disposed about the carrier member, thereby defining a space distal to the pusher member along an outer surface of the carrier member, the outer sleeve member extending at least partially over the space; and

an annular-shaped element received on the carrier member within the space, the annular-shaped element being deployable  
15 from the space upon distal movement of the pusher member relative to the carrier member.

2. The apparatus of claim 1, further comprising an actuator assembly comprising an actuator housing and inner,  
20 intermediate, and outer actuator members that telescope relative to the actuator housing, the actuator housing extending from the proximal end of the elongate member, each actuator member comprising a connector on its distal end for engaging a respective connector on the carrier assembly, thereby coupling

movement of the carrier, pusher, and outer sleeve members to the inner, intermediate, and outer actuator members, respectively.

3. The apparatus of claim 2, wherein the actuator assembly  
5 comprises a control member, and the inner, intermediate, and  
outer actuator members comprise a first set of cooperating  
detents for coupling distal movement of the inner, intermediate,  
and outer actuator members as the control member is directed  
distally, the first set of cooperating detents releasing the  
outer actuator member upon attaining a first distal position,  
thereby permitting further distal movement of the inner and  
intermediate actuator members, and consequently permitting the  
carrier and pusher members to be directed distally beyond the  
outer sleeve member.

4. The apparatus of claim 3, wherein the control member is  
coupled to one of the inner actuator member and the intermediate  
actuator member, and wherein the first set of cooperating detents  
comprise a first detent on the outer actuator member and first  
20 pockets in the inner and intermediate actuator members for  
receiving the first detent therein, the apparatus further  
comprising cooperating ramps on at least one of the actuator  
housing and the outer actuator member, the cooperating ramps  
being configured for disengaging the first detent from the first

pockets upon attaining the first distal position, thereby allowing the inner and intermediate actuator members to be directed distally beyond the first distal position.

5        5.    The apparatus of claim 3, further comprising a second set of cooperating detents on the intermediate actuator member and the inner actuator member for coupling movement of the inner and intermediate actuator members together.

10       6.    The apparatus of claim 5, wherein the second set of cooperating detents comprises a second detent on the intermediate actuator member and a second pocket on the inner actuator member.

15       7.    The apparatus of claim 6, wherein the inner and intermediate actuator members are directable to a second distal position distal to the first distal position, and wherein one of the actuator housing and the outer actuator member comprises a spring element for disengaging the second detent from the second pocket upon attaining the second distal position.

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8.    The apparatus of claim 7, wherein the control member is coupled to the intermediate actuator member, and wherein the intermediate actuator member may be advanced distally beyond the second distal position by directing the control member further

distally, thereby directing the pusher member distally with respect to the carrier member to deploy the annular-shaped element from the space.

5           9.    The apparatus of claim 7, wherein the spring element comprises a beam extending from the outer actuator member through slots in the inner and intermediate actuator members, the beam being received in the second pocket upon attaining the second  
10           distal position, thereby disengaging the second detent and allowing further distal movement of the intermediate member while substantially simultaneously coupling the inner and outer  
            actuator members together.

            10.   The apparatus of claim 2, further comprising:  
15           a locator member connected to the actuator assembly, the locator member having a distal portion extendable distally beyond the distal end of the elongate member;

            one or more positioning elements on the distal portion of the locator member, the positioning elements being expandable  
20           from a collapsed configuration towards a transversely expanded configuration; and

            a locking mechanism on the locator member for releasably retaining the positioning elements in the expanded configuration.

11. The apparatus of claim 10, wherein the elongate member comprises an introducer sheath, and the locator member comprises an obturator insertable into a lumen of the sheath.

5 12. The apparatus of claim 11, wherein the obturator is insertable into the actuator housing and into the lumen of the sheath until the positioning elements are disposed beyond the distal end of the sheath.

13. The apparatus of claim 12, wherein the obturator and actuator housing including cooperating detents for substantially securing the obturator to the actuator housing.

10 14. The apparatus of claim 12, wherein at least one of the  
15 inner, intermediate, and outer actuator members comprises a third detent for engaging a release mechanism within the actuator housing for disengaging the locking mechanism on the locator member, thereby collapsing the positioning elements to the collapsed configuration upon advancement of the at least one of  
20 the inner, intermediate, and outer actuator members to a predetermined distal position.

15. The apparatus of claim 2, wherein the inner, intermediate, and outer actuator members comprise tubular members

including "C" shaped cross-sections over at least substantial portions of their lengths.

16. The apparatus of claim 2, further comprising a hub on  
5 the proximal end of the elongate member, the hub and the housing comprising cooperating connectors for securing the actuator assembly to the elongate member.

17. The apparatus of claim 16, wherein the hub and the  
10 elongate member define a passage therebetween, and wherein the carrier assembly is at least partially disposed within the passage.

18. The apparatus of claim 1, wherein the annular-shaped  
15 member comprises a closure element including a plurality of tissue engaging elements oriented distally along the outer surface of the carrier member.

19. The apparatus of claim 1, wherein the outer sleeve  
20 member extends distally over the carrier member such that a distal end of the outer sleeve member slidably surrounds an outer surface of the elongate member.

20. The apparatus of claim 19, wherein at least one of the carrier member and the pusher member is slidable distally relative to the outer sleeve member, the outer sleeve member being expandable to accommodate at least one of the carrier member and the pusher member sliding between the outer sleeve member and the outer surface of the elongate member.

21. The apparatus of claim 20, wherein the outer sleeve member comprises a plurality of longitudinal slots therein, the slots opening as at least one of the carrier member and the pusher member is slid distally to expand the outer sleeve member.

22. The apparatus of claim 21, wherein the plurality of longitudinal slots are staggered such that the outer sleeve member assumes a zigzag mesh configuration as it expands.

23. The apparatus of claim 21, wherein the plurality of longitudinal slots have a spiral shape.

24. The apparatus of claim 19, wherein the outer sleeve member extends at last about fifteen millimeters beyond a distal end of the carrier member before at least one of the carrier member and the pusher member is advanced relative to the outer sleeve member.

25. An apparatus for delivering a closure device from a carrier assembly slidably carried by an elongate member, comprising:

5 a housing comprising proximal and distal ends, the distal end comprising a connector for mating to a proximal end of the elongate member;

inner, intermediate, and outer actuator members that are nested together and telescope relative to the housing, each actuator member comprising a connector on its distal end for engaging a respective member on the carrier assembly, thereby coupling distal movement of the carrier assembly to distal movement of the inner, intermediate, and outer actuator members;

15 a control member coupled to at least one of the inner, intermediate, and outer actuator members;

20 cooperating detents on the inner, intermediate, and outer actuator members for coupling together distal movement of the inner, intermediate, and outer actuator members as the control member is directed distally, the cooperating detents releasing the outer actuator member upon attaining a first distal position, thereby permitting further distal movement of the inner and intermediate actuator members with respect to the outer actuator member.



26. The apparatus of claim 25, wherein the control member is coupled to one of the inner actuator member and the intermediate actuator member, and wherein the cooperating detents comprise first cooperating detents on the inner, intermediate, and outer actuator members, the apparatus further comprising cooperating ramps on at least one of the housing and the outer actuator member, the cooperating ramps being configured for disengaging the first cooperating detents upon attaining the first distal position, thereby allowing the inner and intermediate actuator members to be directed distally beyond the first distal position by the control member.

27. The apparatus of claim 26, wherein the cooperating detents further comprise second cooperating detents on the inner and intermediate actuator members for coupling distal movement of the inner and intermediate tubular members together, and wherein one of the housing and the outer actuator member comprises an element for disengaging the second cooperating detents upon attaining a second distal position distal to the first distal position.

28. The apparatus of claim 27, wherein the control member is coupled to the intermediate actuator member, and wherein the intermediate actuator member may be advanced distally beyond the

second distal position by directing the control member further distally, thereby directing the pusher member distally with respect to the carrier member to deploy the closure element from the annular space.

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29. An apparatus for delivering a closure device, comprising:

a sheath comprising a lumen extending between proximal distal ends, and including a carrier assembly slidably carried by the sheath, the carrier assembly comprising a closure element carried by the carrier assembly;

an actuator assembly comprising an actuator housing connected to the proximal end of the sheath, a plurality of telescoping actuator members connected to the carrier assembly;

15 an obturator in the actuator housing, a distal portion of the obturator extending through the lumen of the sheath and beyond a distal end of the sheath, the distal portion comprising one or more positioning elements expandable from a collapsed configuration to a transverse expanded configuration, the  
20 obturator also comprising a locking mechanism for releasably securing the positioning elements in the expanded configuration; and

a release mechanism in the actuator housing coupled to at least one of the telescoping actuator members and the obturator,

the release mechanism automatically releasing the locking mechanism when the at least one of the telescoping actuator members is advanced distally to a predetermined location to contract the positioning elements to the collapsed configuration.

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30. An apparatus for delivering a closure element into an opening through tissue, comprising:

an elongate member comprising proximal and distal ends;

10 a carrier assembly slidable on the elongate member, the carrier assembly comprising an inner carrier member, and a pusher member overlying the carrier member, thereby defining a space distal to the pusher member along an outer surface of the carrier member;

15 an annular-shaped closure element received on the carrier member within the space, the closure element being deployable from the space upon distal movement of the pusher member relative to the carrier member; and

20 an actuator assembly connected to the proximal end of the elongate member, the actuator assembly comprising a plurality of telescoping members coupled to the carrier assembly, the actuator assembly configured for advancing the carrier assembly distally to a predetermined position, whereupon the pusher member is movable distally with respect to the inner carrier member for deploying the closure element from the space.

31. The apparatus of claim 30, wherein the carrier assembly further comprises an outer sleeve member extending at least partially over the space, thereby at least partially covering the closure element, the actuator assembly configured for limiting  
5 distal movement of the outer sleeve member such that the closure element is at least partially exposed from the outer sleeve member before the carrier assembly attains the predetermined position.

32. A method for delivering a closure element to close an opening through tissue, the method comprising:

inserting a distal end of an elongate member into an opening through tissue;

15 advancing a carrier assembly over the elongate member towards the distal end of the elongate member, the carrier assembly comprising a carrier member carrying a closure element, and an outer sleeve covering the closure element;

20 discontinuing advancing the outer sleeve, while continuing to advance the carrier member and the closure element, thereby causing the outer sleeve to expand as the carrier member and the closure element pass thereunder; and

deploying the closure element from the elongate member to close the opening.

33. The method of claim 32, wherein the deploying step comprises withdrawing the elongate member from the opening.

5 34. The method of claim 32, wherein the carrier assembly further comprises a pusher member, and wherein the deploying step comprises advancing the pusher member relative to the carrier member, thereby deploying the closure element from the carrier assembly.

10 35. The method of claim 32, wherein the outer sleeve comprises a weakened region extending towards the distal end of the elongate member, the weakened region tearing as the carrier member and closure element are advanced relative to the outer sleeve.

15 36. The method of claim 32, wherein the outer sleeve comprises a plurality of longitudinal slots, the slots opening as the carrier member and closure element are advanced relative to the outer sleeve, thereby expanding the outer sleeve.

20 37. The method of claim 36, wherein the longitudinal slots are staggered relative to one another such that the outer sleeve assumes a zigzag mesh configuration as it expands.

38. The method of claim 36, wherein the slots comprise spiral slots, the outer sleeve twisting as it expands.

5 39. The method of claim 32, wherein the opening through tissue extends through one or more layers of fascia, and wherein advancing step comprises advancing the outer sleeve through the one or more layers of fascia before discontinuing advancing the outer sleeve.

40. The method of claim 39, wherein the outer sleeve extends distally beyond the carrier member when the carrier assembly is advanced, the outer sleeve sliding along an outer surface of the elongate member to guide the carrier assembly  
15 through the one or more layers of fascia.

41. The method of claim 32, wherein the opening through tissue communicates with a blood vessel, and wherein the deploying step comprises substantially sealing the opening from  
20 blood flow therethrough with the closure element.

42. The method of claim 41, wherein the elongate member comprises an introducer sheath, and wherein the method further

comprises introducing one or more devices through the introducer sheath into the blood vessel to perform a procedure.